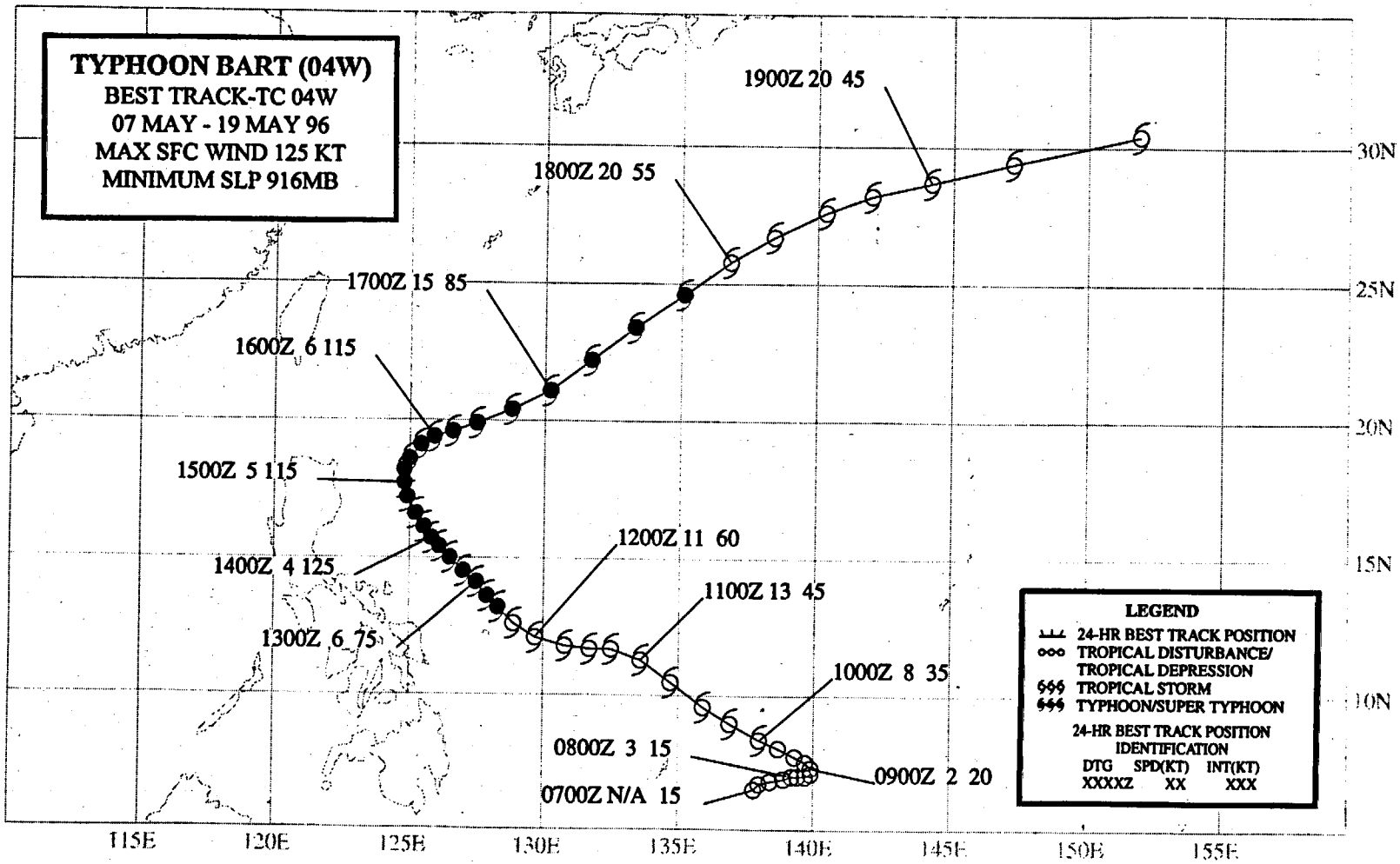
TYPHOON BART (04W)
BEST TRACK-TC 04W
07 MAY - 19 MAY 96
MAX SFC WIND 125 KT
MINIMUM SLP 916MB
1900Z 20 45
1800Z 20 55
1700Z 15 85
1600Z 6 115
1500Z 5 115
1400Z 4 125
1300Z 6 75
1200Z 11 60
1100Z 13 45
1000Z 8 35
0900Z 2 20
0800Z 3 15
0700Z N/A 15
30N
25N
20N
15N
10N
115E
120E
125E
130E
135E
140E
145E
150E
155E
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XXX

TYPHOON BART (04W)

I. HIGHLIGHTS

Bart was the first western North Pacific (WNP) TC of 1996 to reach typhoon intensity. It became a very intense typhoon, peaking at 125 kt (64 m/sec). Initially moving toward the Philippines, it turned to the north and remained at sea. Pronounced diurnal variations in Bart's central deep convection were noted.

II. TRACK AND INTENSITY

During the first week of May, the tropics of the WNP were dominated by low-level easterly wind flow accompanied by westerly wind flow aloft. A zonally-oriented band of convection stretched east-west across Micronesia south of 10°N. This convection was highly sheared from the west, and possessed a structure more characteristic of the convergence-zone cloud band that normally dominates the central North Pacific; that is, a linear band of disorganized mesoscale convective systems located along the confluence line of the northeast and southeast trades. This synoptic regime slowly changed, and by 05 May, monsoonal low-level westerly winds had penetrated into the WNP eastward to 140°E and south of 5°N. Accompanying the arrival of the monsoonal westerlies, amounts of deep convection increased in the southern portion of the Philippine Sea, and the cirrus outflow from this region became organized into a pattern indicative of an anticyclone aloft.

As amounts of deep convection began to increase in this area, the region of persistent deep convection that became Bart was first noted on the Significant Tropical Weather Advisory valid at 050600Z May. Remarks on the advisory included:

"Convective activity (near 4°N 136°E) has increased.... Visible satellite imagery and synoptic data indicate the presence of a weak circulation beneath diffluent upper-level winds. Surface and gradient level (3000 ft) analysis indicate 10-knot westerly winds along the equator enhancing surface convergence. . . . Minimum sea level pressure is estimated to be 1007 mb. . . ."

For the next four days, this disturbance — which now possessed the characteristics of a monsoon depression (see definitions section) — was slow to gain organization (e.g., well-defined low-level cloud lines, and persistent central convection). Based upon satellite imagery showing the system had acquired a small area of persistent central deep convection associated with well-defined low-level cloud lines, a Tropical Cyclone Formation Alert (TCFA) was issued valid at 090300Z May. Shortly after the TCFA was issue, cloud-top temperatures of the area of central deep convection became colder on infrared satellite imagery, and the first warning on Tropical Depression (TD) 04W was issued valid at 090600Z. Based upon indication of some shearing from the east, and implications of the structure of the system (i.e., a monsoon depression), a slower than normal rate of intensification was forecast.

Eighteen hours later (100000Z), TD 04W was upgraded to Tropical Storm Bart, based upon an improved satellite signature (an increase in the areal extent of very cold central convection), and upon the indication of 35-kt (18-m/sec) surface wind speeds from microwave imagery. A gradual turn from a westward motion to a more northward track was indicated on this warning — a track that would now spare the Philippines a landfall. With relatively low environmental shear, Bart was now forecast to intensify at a normal rate and become a typhoon in 48 hours (i.e., at 120000Z).

Evolving a classic banding-type eye (Dvorak, 1984) (see definitions section), Bart was upgraded to a typhoon at 121200Z. After becoming a typhoon, Bart began to intensify more rapidly, and reached its peak intensity of 125 kt (64 m/sec) at 140000Z (Figure 3-04-1). The estimated fall

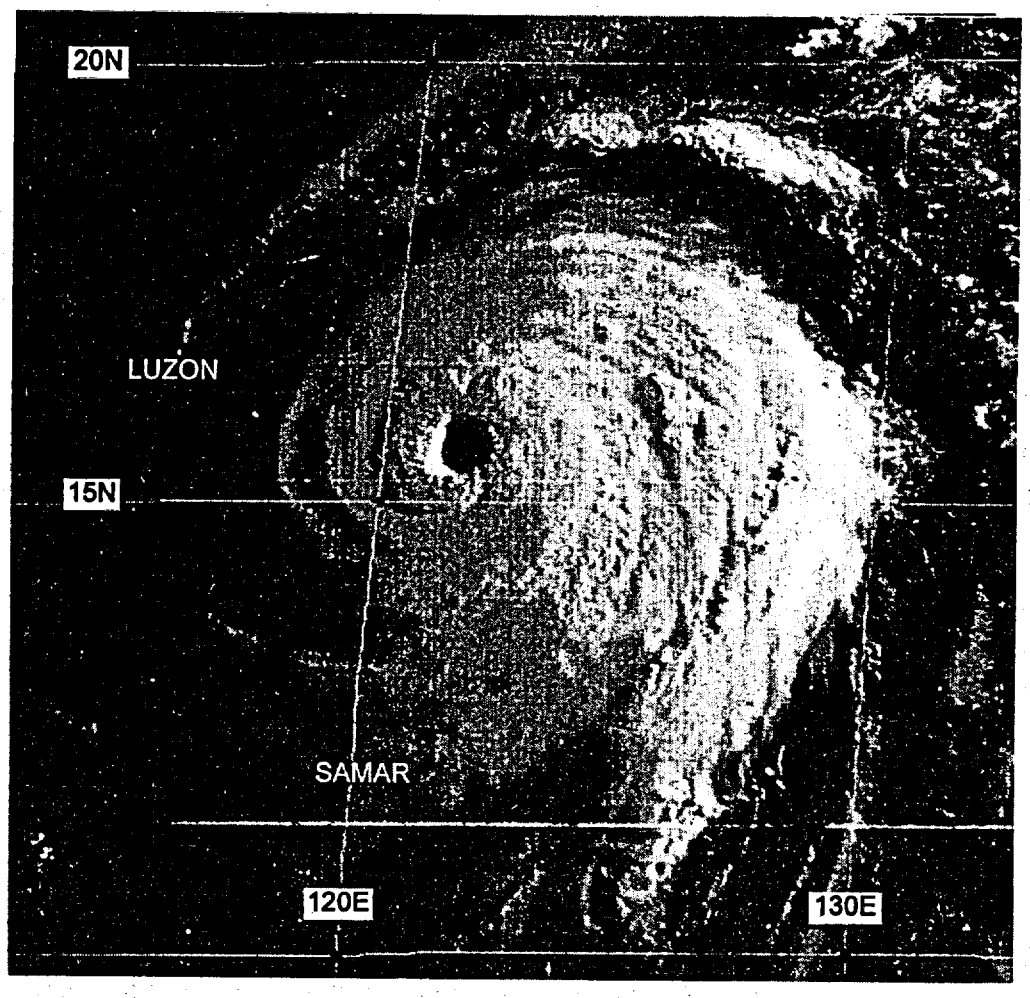

Figure 3-04-1 Bart reaches its peak intensity (132131Z May GMS visible imagery).

of central pressure of 52 mb during the 24-hour period, 130000Z to 140000Z, was sufficient to be classified as rapid intensification (Holliday and Thompson, 1979) (see definitions section).

Twenty-four hours after reaching peak intensity (i.e., at 150000Z), Bart reached its point of recurvature at 18°N, which is the climatological mean latitude of recurvature during May (Shanghai Typhoon Institute, 1990). Following recurvature at 150000Z, Bart did not begin to significantly accelerate until after 170000Z. Also during this period of slow east-northeast motion, its intensity fell only gradually. As Bart began to accelerate on 17 May, its intensity began to decrease — falling below typhoon intensity after 171800Z. On 18 May, its speed of forward motion increased to 20 kt (37 km/hr), and Bart began to shear while undergoing extratropical transition. The final warning was issued valid at 181800Z as Bart lost all its central deep convection and completed its extratropical transition.

III. DISCUSSION

Use of digital Dvorak (DD) numbers

One of the utilities installed in the MIDDAS satellite image processing equipment is an automated routine for computing Dvorak "T" numbers for TCs that possess eyes. The routine, developed by Zehr (personal communication) and programmed by Schaeffer (personal communication), adapts the rules of the Dvorak technique as subjectively applied to enhanced-infrared imagery (Dvorak, 1984) in order to arrive at an objective T number, or "digital Dvorak" T number (hereafter

referred to as DD numbers). Infrared imagery is available hourly from the GMS satellite, and hourly DD numbers were calculated for all of the typhoons of 1996.

The DD numbers presented herein are experimental, and methods for incorporating them into operational practice are being explored. In some cases, the DD numbers differ substantially from the warning intensity and also from the subjectively determined T numbers obtained from application of Dvorak's technique. The output of the DD algorithm, when performed hourly, often undergoes rapid and large fluctuations. The fluctuations of the DD numbers may lay the ground work for future modifications to the current methods of estimating tropical cyclone intensity from satellite imagery. The discussion of the behavior of the time series of the DD numbers for Bart, and for some of the other typhoons of 1996, is intended to highlight certain aspects of the DD time series that may prove to have important research and/or warning implications.

In Dvorak's 1975 and 1984 papers, he advises that the intensity estimation from satellite imagery be made at 24-hour intervals in order to remove any possible diurnal cycles that the TC might be undergoing. Dvorak further claims that the intensity of a TC is not influenced by diurnal changes in the central convection. Diurnal variations of convection reported to occur in TCs are similar to those reported to occur over the marine tropics in general: a peak in the amount of very cold cloud tops during the early morning hours with warmer cloud-top temperatures during the afternoon (Dvorak, 1985; Zehr, 1992). Observations by Black and collaborators (e.g., Black, 1983; Black et al., 1986; Black and Marks, 1987) show that major cold convective eruptions in TCs tend to be initiated in the early morning.

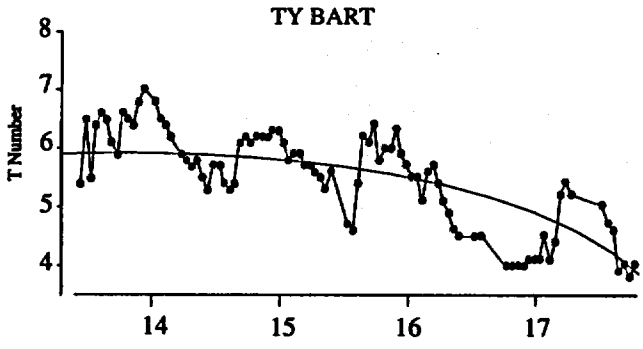

Figure 3-04-2 Bart's DD time series for the period 131030Z May through 171530Z May.

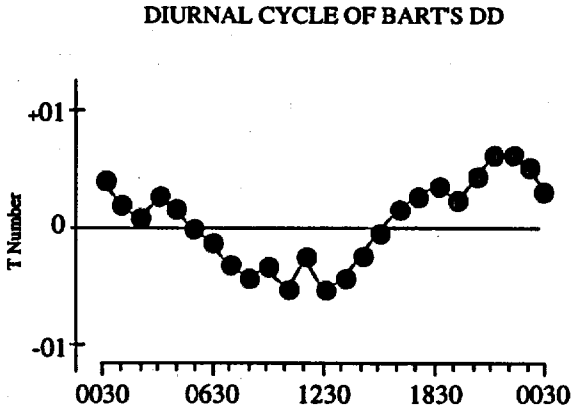

Figure 3-04-3 The diurnal cycle of Bart's DD time series as obtained by averaging the DD numbers at each hour during the period 131030Z May through 160930Z.

Bart is one of only a few cases during the past two years in which a strong diurnal cycle can be found in the time series of its DD numbers (Figure 3-04-2). Although the DD number is based upon both the cloud-top temperature of the eye-wall cloud and the temperature within the eye, the strong diurnal cycle in Bart's DD time series (Figure 3-04-3) is certainly linked to a diurnal cycle of the eye-wall cloud-top temperatures. The DD time series of Bart has an unusually strong diurnal cycle when compared with those of other typhoons of 1996 and with those typhoons of 1995 for which the DD time series was compiled (see the 1995 ATCR). Consistent with Dvorak's rules, Bart's warning and best track intensities do not contain the large diurnal fluctuations that appear in its DD time series.

IV. IMPACT

No reports of significant damage or injuries were received at the JTWC.